JS|HELD

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August 17, 2023

Michael Levin
Flager & Associates, P.C.
1210 Northbrook Drive, Suite 280
Trevose, Pennsylvania 19053

RE: *Miller et al. v City of Philadelphia et al.*

Dear Mr. Levin,

As requested, JS Held investigated a Police pursuit that occurred shortly before 7:30pm on May 7th, 2019, in the neighborhood of Bridesburg, in Philadelphia, Pennsylvania. According to the *Internal Investigation Memorandum*, Mr. Ryan Miller, who was operating a Yamaha Scooter was being "pursued by police at the time of the incident." [1] Officer Joseph Wolk, who was operating a Philadelphia Police patrol vehicle, can be seen in surveillance video, following Mr. Miller through the neighborhood prior to the crash. At the end of this pursuit, Mr. Miller died as a result of a collision with a tractor trailer at the intersection of Tacony Street and Fraley Street. *Figure 1* depicts an aerial image from Google Earth™ dated June 5, 2022, that depicts the general area where Mr. Miller was operating his motorcycle during the pursuit by Officer Wolk. The series of streets through which the pursuit was captured on video is depicted with an orange rectangle, and the specific intersection where the collision with the tractor trailer occurred is denoted with a red circle. The speed limit in the neighborhood is 25mph. At the time of the accident the weather was clear, the roadway was dry, and it was dusk.[2]

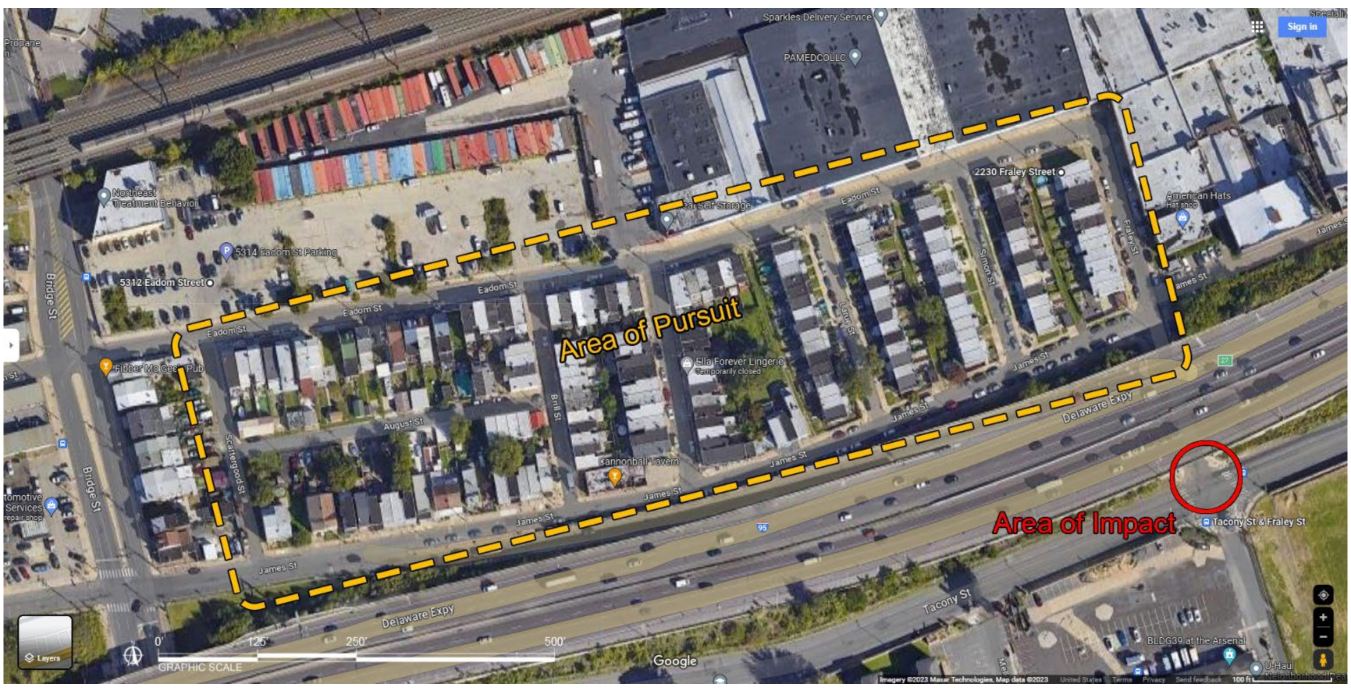


*Figure 1 – Aerial of area where this incident occurred, Google Earth aerial image dated June 5, 2022*

[1] Internal Investigation IAD # 19-1066 BATES DEFENSE 000004
[2] Commonwealth of Pennsylvania Police Crash report, Incident # 201915044176, p. 1

**Background:**
William Neale:
I currently hold the position of Vice President and Director of Visualization at JS Held, a Forensic Engineering and Visualization firm. I have held this position since July 2021, and prior to that, from 2005 to 2021, I held the same position at Kineticorp, LLC, also a Forensic Engineering and Visualization firm in Denver, Colorado. My responsibilities as Vice President and Director of Visualization include training and teaching JS Held staff, managing staff operations, technology, and projects, and developing and directing the technology related to accident reconstruction, forensics, photogrammetry, video analysis, computer modeling, visualization, and simulation. I also work as an expert consultant in accident reconstruction specializing in accident reconstruction, lighting and visibility, photogrammetry and video analysis, and computer visualization. I am an accredited Traffic Accident Reconstructionist through the Accreditation Commission for Traffic Accident Reconstruction (ACTAR #2571). I am also a certified Motorcycle Safety Instructor (MSF #138364) and certified in instruction of the Advanced Rider's Course (MSF #L196094) and am currently involved as a Quality Assurance Specialist in the State of Colorado. I administer the licensing waiver exam to motorcycle students seeking to obtain a license with the "M" class endorsement. I am certified to teach the Basic Riders Course™ as well as the Advanced Riders Course™. I have been certified in Level I and Level II Motorcycle Accident Scene Management and took Motorcycle Reconstruction coursework at Northwestern University School for Public Safety. I was elected to serve on Colorado's Motorcycle Safety Operation Advisory Board (MOSAB), for a two-year term from 2013-2015. On this board, I was the appointed representative of the approximate 300 Colorado nationally certified motorcycle instructors. Since 2005 my daily work has included reconstruction of accidents involving trucks, cars, motorcycles, and bicycles as well as incidents involving pedestrians, equipment and machinery. I am a member of the Society of Automotive Engineers (SAE) and have published over 40 peer reviewed scientific articles on the topic of accident reconstruction, video analysis, photogrammetry, visualization, and lighting and visibility. I have presented these papers to the Safety and Testing and Human Factors and Lighting session at the Annual Congress. In addition, SAE has published the book I co-authored, "Motorcycle Accident Reconstruction", released in December of 2018. In May of 2020, this book received the IBPA Benjamin Franklin *Silver Medal* in the category of "Professional and Technical" published books. I have been invited to lecture on the topics of accident reconstruction, lighting and visibility, and computer visualization at the Art Institute of Colorado, Wayne State University, and California State University in Los Angeles. I received the 2006 Arch T. Colwell award for my research in video tracking and photogrammetry and received funding for research in this field from DriveCam – The Driver Science Company, Ford Motor Company, The Milwaukee Brewers, and The National Football League (NFL). I designed and teach the curriculum for the ACTAR accredited course "Photogrammetry and Analysis of Digital Media", a course that examines and teaches the principles, practices, and procedures of photogrammetry, photographic and video analysis, video tracking, lighting and visibility and procedures for obtaining calibrated video. I obtained my bachelor's and master's degrees from Washington University in St. Louis where I studied photogrammetry, photography and videography, lighting and computer visualization and simulation. In addition, I was trained in accident reconstruction, lighting and visibility, and human factors at the Northwestern University Center for Public Safety and at the University of Michigan (Human Factors Engineering Short Course). A copy of curriculum vitae is attached as *Appendix A*.

**Overview of Scope of Work:**
JS Held was asked to investigate and reconstruct this collision. This involved inspecting, documenting and scanning the area where the pursuit occurred, and where several surveillance cameras were located that captured, in part, the sequence of the pursuit. JS Held analyzed the provided video and tracked the motion, position, speed, steering, acceleration and deceleration of the vehicles. JS Held then evaluated and compared these values to known values of typical drivers on similar roadways, or faced with similar situations.

**Procedures:**

- In conducting this investigation and analysis, JS Held reviewed and analyzed the documents, materials, photographs, and video files listed in *Appendix B*. These materials were provided to JS Held.

- JS Held obtained Google Earth™ aerial imagery of the location where this incident occurred.

- On April 26, 2023, JS Held inspected, documented, scanned, and photographed the neighborhood and relevant streets where this pursuit occurred.

- JS Held processed this scan data into a three-dimensional model of the area of the incident, based on the specific views that were captured on video.

- Using processes of video tracking and photogrammetry, JS Held analyzed the provided video to determine the position and movement, over time, of the relevant vehicles that are observable in the surveillance video.

- From the scaled computer model of the scene and the tracked positions of the vehicle in the video, JS Held created a real time reconstruction of the incident sequence.

- JS Held analyzed the motion of Officer Wolk, determining the speeds he achieved, and analyzing two maneuvers where Officer Wolk swerved and stopped, blocking the travel path of Mr. Miller.

- JS Held created visualization material that describes the procedures outlined in this report, and findings listed in the conclusions.

**Scene Inspection and Scaled diagram:**
On April 26, 2023, JS Held inspected, documented, and performed three-dimensional laser scanning of the accident site. *Figure 2* depicts the accident site at the time of our inspection. These photographs depict intersections where Officer Wolk interacted with Mr. Miller, and where the interaction was captured on video. The image on the left is at the intersection of Scattergood Street and Eadom Street. The image on the right is at the intersection of Brill Street and James Street. For reference, *Figure 3* depicts still images from the surveillance footage that obtained recordings of the incident at these respective intersections.

*Figure 2 – JS Held Scene inspection photographs of two intersections where video footage was recorded.*

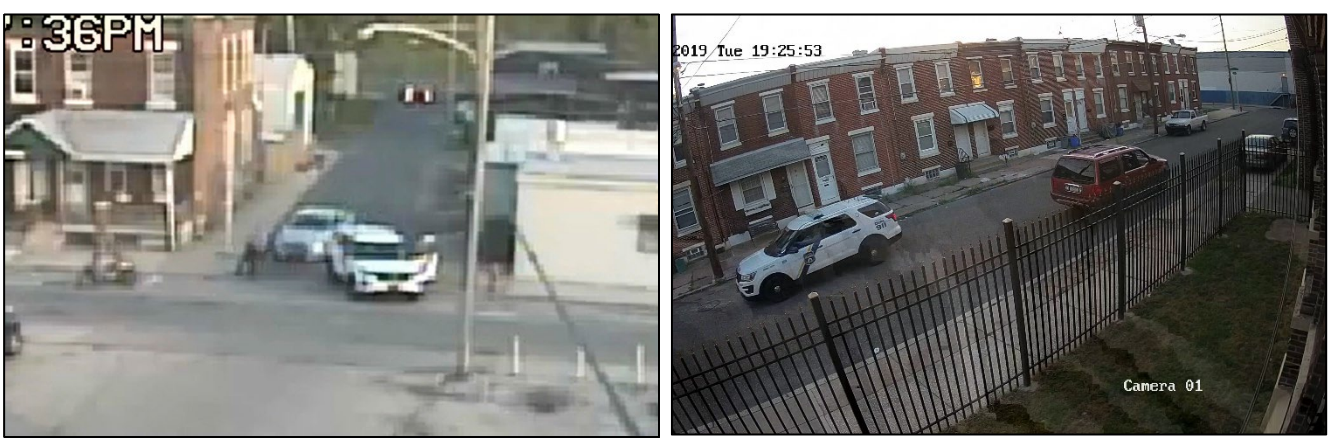


*Figure 3 – Corresponding surveillance video still images of the intersections shown in Figure 2.*

During the inspection of the scene, JS Held used a Leica RTC 360 3D laser scanner to digitize the area. *Figure 4* depicts the intersection at Scattergood Street and Eadom Street, viewed in three-dimensions from the location of the surveillance camera that recorded a portion of the pursuit.

*Figure 4 – Perspective view of the scan data at the intersection of Scattergood St. and Eadom St.*

A total of 20 scans were performed at 5 different intersections, gathering more than 400 million scan data points at the scene. Collectively, these points captured the geometry of the roadway, curbs, buildings, and other features in and around the accident area. The scan data was processed in Leica Cyclone 360+ software and imported into Autodesk's AutoCAD 2023 and Autodesk's 3DS Max software as a fully scaled point cloud. This was combined with the scaled aerial from Google Earth. *Figures 5* depicts a top down view denoting the locations of each scan, overlaid on the aerial.

*Figure 5 – Top down view showing locations of the scans performed during JS Held's scene inspection.*

**<u>Video analysis and tracking of the Patrol vehicle, Yamaha Scooter, and additional vehicle:</u>**
JS Held was provided with several video files directly from security cameras, or indirectly through cell phone screen recordings of security footage. These videos captured, in part, the sequence of this pursuit. A total of 52 video files were provided to JS Held, of which 10 Files were selected for analysis given the information contained in those recordings. *Table 1* summarizes the videos provided to JS Held, that were selected for analysis, and their general video specifications.

| JSH Camera Name | Source File Name | converted file name | Video Source | Location/viewpoint | Resolution | FPS | Codec | Format | Duration |
|---|---|---|---|---|---|---|---|---|---|
| Camera 01 | ch13_20190507192406.mp4 | cam-01.mp4 | security camera | Fraley st. and James St. | 2688x1520 | 20 | H264-MPEG-4 AVC (part 10) | .mp4 | 55 sec. |
| Camera 02 | XVR_ch5_main_20190507191500_20190507193500.dav | cam-02.mp4 | security camera | Eadom St. | 1280x720 | 30 | H264-MPEG-4 AVC (part 10) | .dav | |
| Camera 03 | Video footage 5-7-19(provided by Ashley Zehnder) (2).mov | cam-03.mp4 | cell phone of monitor | Brill st. and James St. | 1280x720 | 30 | avc1 | .mov | 24 sec. |
| Camera 04 | Alley_7_25PM starts at 7-27.mp4 | cam-04.mp4 | security camera | Scattergood St. and Eadom St. | 640x480 | 29.97 | avc1 | .mp4 | 5 min |
| Camera 05 | 1220-2448-recfile_-190507-060000-065959-00001500.mp4 | cam-05.mp4 | security camera | Eadom St. | 1280x720 | 30 | avc1 | .mp4 | 12 min. 28 sec. |
| Camera 06 | XVR_ch5_main_20190507191500_20190507193500.dav | cam-06.mp4 | security camera | Eadom St. | 1280x720 | 30 | H264-MPEG-4 AVC (part 10) | .dav | 20 min. |
| Camera 07 | ch08_20190507192525.mp4 | cam-07.mp4 | security camera | Eadom St. and Fraley St. | 2688x1520 | 20 | H264-MPEG-4 AVC (part 10) | .mp4 | 21 sec. |
| | ch08_20190507192542.mp4 | | security camera | Eadom St. and Fraley St. | 2688x1520 | 20 | H264-MPEG-4 AVC (part 10) | .mp4 | 27 sec. |
| Camera 08 | ch13_20190507192545.mp4 | cam-08.mp4 | security camera | Fraley st. and James St. | 2688x1520 | 20 | H264-MPEG-4 AVC (part 10) | .mp4 | 38 sec. |
| Camera 09 | Camera 3_20190507_192400.mov | cam-09.mp4 | security camera | Fraley St. | 1920x108 | 14.63 | avc1 | .mov | 36 sec. |

*Table 1 – Specification summary of the provided video files that were analyzed.*

The original provided video files were processed combined, or cropped to the time frame that shows events that can be analyzed. Additionally, some files were converted from their source compression format into a more universal format of MP4 and renamed for organizational purposes. For the files that required conversion, JS Held used the software Input Ace to import the files and export into the MP4 format that allowed analysis of the content frame by frame, and for camera matching and video tracking the vehicles as observed in the video. None of these changes made to the source video files altered the content of the videos. There are only 7 actual security cameras, but since two of the cameras recorded two separate times that the vehicles proceed through the camera's field of view, these were given unique camera numbers. Thus, we identify a total of 9 cameras, which correspond to 9 separate sequences that were analyzed. *Figures 6* depicts an aerial image showing the location of the cameras, including the general field of view of each camera. *Figures 7* to *Figures 15* depict a series of still images from each of the video files selected for analysis, that show the general vantage point of the cameras.


*Figure 6 – Top down diagram showing the security cameras' locations and field of view.*

*Figure 7 – Still Images from Camera-01 - "ch13_20190507192406.mp4"*

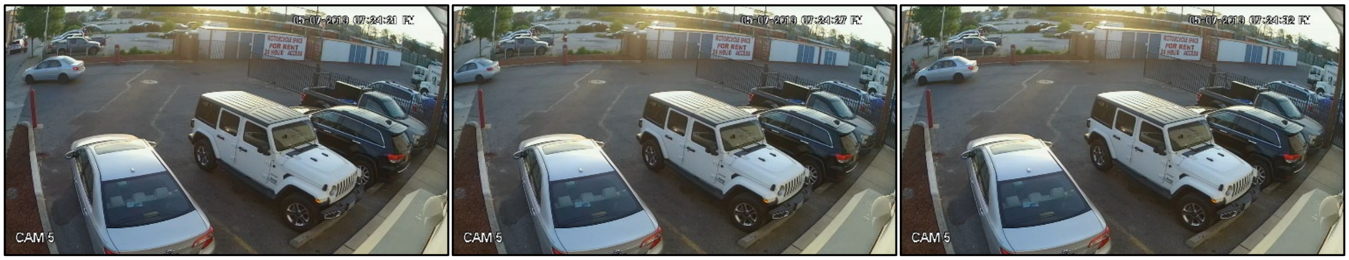

*Figure 8 – Still Images from Camera-02 – "XVR_ch5_main_20190507191500_20190507193500.dav"*

*Figure 9 – Still Images from Camera-03 - "Video footage 5-7-19(provided by Ashley Zehnder) (2).mov"*

*Figure 10 – Still Images from Camera-04 - "Alley_7_25PM starts at 7-27.mp4"*

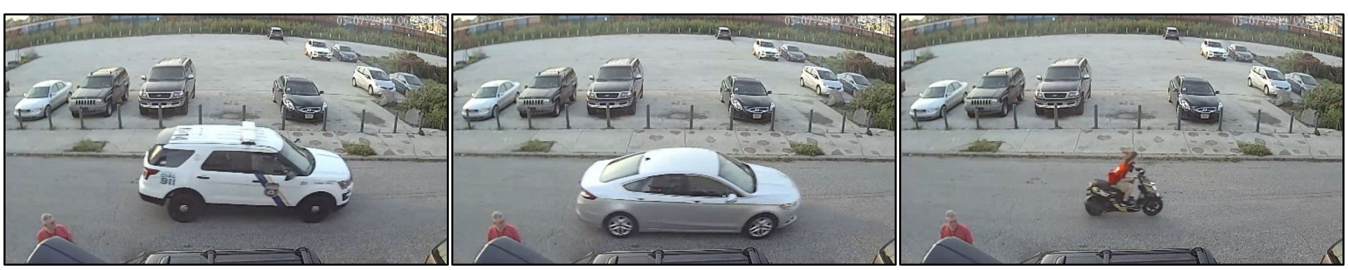

*Figure 11– Still Images from Camera-05 - "1220-2448-recfile_-190507-060000-065959-00001500.mp4"*

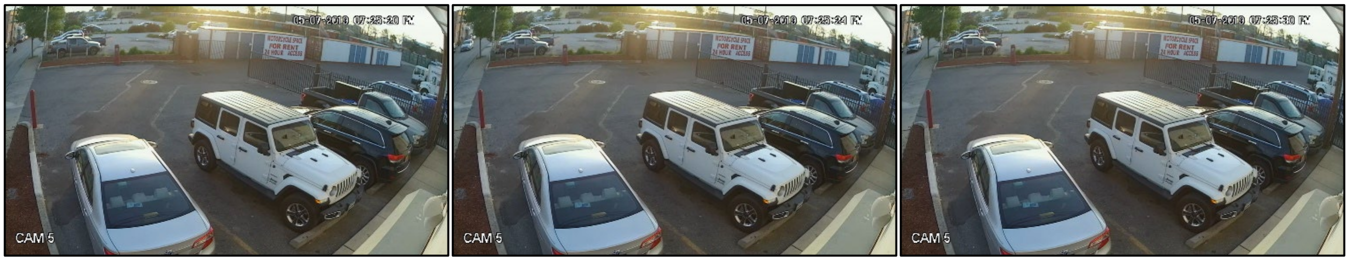


*Figure 12 – Still Images from Camera-06 - "XVR_ch5_main_20190507191500_20190507193500.dav"*

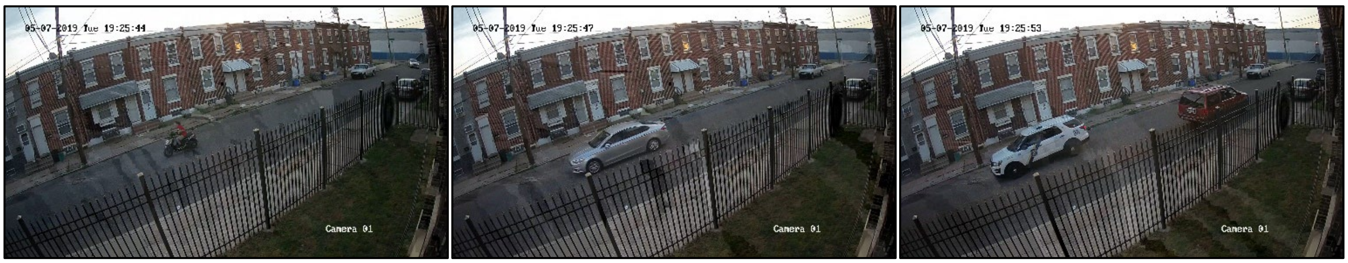


*Figure 13 – Still Images from Camera-07 - "ch08_20190507192542.mp4", "ch08_20190507192525.mp4"*


*Figure 14 – Still Images from Camera-08 - "ch13_20190507192545.mp4"*

*Figure 15 – Still Images from Camera-09 - "Camera 3_20190507_192400.mov"*

In this case, three vehicles were involved: Mr. Miller and his Yamaha scooter, Officer Wolk, and his patrol vehicle, and then a third vehicle which was a silver 2013-2020 model year Ford Fusion being operated by Mr. Gary Bove.[3] Images of these three vehicles, obtained from still images of the video recordings, are depicted in *Figure 16*.

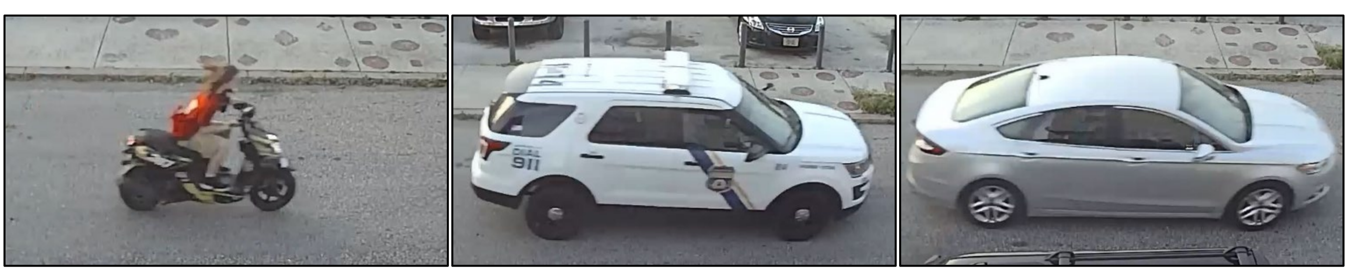


*Figure 16– Mr. Miller's Yamaha Scooter, Officer Wolk's patrol vehicle, Mr. Bove's Ford Fusion*

[3] Deposition of Officer Joseph Wolk, May 12, 2023, p. 77, lines 1-9

Based on vehicle specifications, computer models of each of the involved vehicles were created and added to the computer model of the scene. The models are accurately scaled reproductions of the subject vehicles, used in the tracking process, and in the production of visualization material.

*Figure 17– Mr. Miller's Yamaha Scooter, Officer Wolk's Patrol vehicle, Mr. Bove's Ford Fusion*

JS Held analyzed the provided videos, determining their location, their camera characteristics, and the sections of the event that were recorded that are relevant to the reconstruction of the tracking of the motion of the vehicles involved in this incident. Using the fully scaled computer model of the scene, JS Held first camera matched the location of each surveillance camera. After determining the three-dimensional location of the camera, the three vehicles, when they appear in the video, were tracked along the three dimensional model that was generated from scanning the scene. JS Held employed widely used and accepted techniques and methodologies of computer visualization, photogrammetry and videogrammetry. Photogrammetry and videogrammetry encompass techniques used to obtain measurements and three-dimensional positional data from photographs and video. These principles and techniques are widely accepted and used within the field of accident reconstruction and visualization. The following technical literature describes the computer modeling and photogrammetric principles and techniques employed by JS Held.


- Terpstra, T., Hashemian, A., Gillihan, R., King, E. Miller, S., **Neale, W.**, "Accuracies in Single Image Camera Matching Photogrammetry," SAE Technical Paper 2021-01-0888, 2021, doi:10.4271/2021-01-0888.

- Terpstra, T., **Neale, W.**, Owens, T., King, E. Beier, S., Voitel, T. An Analysis of Body-Worn Camera Photogrammetry Using Depth Mapping. Proceedings of the American Society of Forensic Sciences, 73rd Annual Scientific Meeting, Atlanta, GA. 2021. C21.

- Terpstra, T., **Neale, W.**, King, E., Hashemian, A., Hessel, D. Determining Range of Certainty in Photogrammetry and Videogrammetry. Proceedings of the American Society of Forensic Sciences, 73rd Annual Scientific Meeting, Atlanta, GA. 2021. C22.

- Terpstra, T., Beier, S., **Neale, W.T.C**., "The Application of Augmented Reality to Reverse Camera Projection," SAE Technical Paper, 2019-01-0424, 2019, doi:10.4271/2019-01-0424.

- Bailey, A., Funk, J., Lessley, D., Sherwood, C., Crandall, J., **Neale, W.T.C**, Rose, N., "Validation of a Videogrammetry Technique for Analysing American Football Helmet Kinematics," Sports Biomechanics (RSPB), Article ID RSPB 1513059; doi: 10.1080/14763141.2018.1513059.

- **Neale, W.T.C.**, Terpstra, T., Hashemian, A., "Photogrammetry and Analysis of Digital Media" Published through SAE Technical Course Material, Troy Michigan. (2017).

- Carter, Neal, Hashemian, Alireza, Rose, Nathan A. and **Neale, W.T.C**, "Evaluation of the Accuracy of Image Based Scanning as a Basis for Photogrammetric Reconstruction of Physical Evidence", Paper Number 2016-01-1467 Society of Automotive Engineers, 2016.

- **Neale, W.T.C.**, Hessel, D., Terpstra, T., "Photogrammetric Measurement Error Associated with Lens Distortion," 2011-01-0286, Society of Automotive Engineers, Warrendale, PA, 2011.

- Rose, Nathan A., **Neale, W.T.C.**, Fenton, S.J., Hessel, D., McCoy, R.W., Chou, C.C., "A Method to Quantify Vehicle Dynamics and Deformation for Vehicle Rollover Tests Using Camera-Matching Video Analysis," 2008-01-0350 Society of Automotive Engineers, Warrendale, PA, 2008.

- Rucoba, R., Duran, A., Carr, L., Erdeljac, D. "A Three-Dimensional Crush Measurement Methodology Using Two-Dimensional Photographs." Society of Automotive Engineers Paper Number 2008-01-0163.

- Chou, C., McCoy, R., Fenton, S., **Neale, W.**, Rose, N., "Image Analysis of Rollover Crash Test Using Photogrammetry," 2006-01-0723, Society of Automotive Engineers, 2006.

- Fenton, S., **Neale, W.**, Rose, N., Hughes, C., "Determining Crash Data Using Camera-Matching Photogrammetric Technique," 2001-01-3313, Society of Automotive Engineers, Warrendale, PA, 2001.

The technique that JS Held used is referred to as camera-matching photogrammetry. This technique involves the following steps:

(1) Computer-modeling software is used to create a three-dimensional computer model of the crash scene from data that was collected at the scene with scanning equipment. This computer model includes features of the environment that were present at the time of the accident such as the roadway, buildings, signage and other unique aspects of the environment.

(2) The computer-modeled environment is then imported into a modeling software package, and a computer-modeled camera is setup to view the computer environment from perspectives that are similar to the perspectives characterized in the still video frames that recorded the incident.

(3) Each of the accident scene photographs or still video images to be analyzed are imported into the modeling software and designated as a background image for the corresponding computer-modeled camera with the same perspective.

(4) Adjustments to the location, focal length and target location of the computer-modeled camera are made until there is an overlay between the computer-generated environment model and the environment shown in the photograph.

(5) Once the camera location and characteristics are determined and the overlay between the environment model and the photograph is obtained, the position of vehicles that traverse along the roadway in the video, can be tracked. Since time can be obtained from the video footage, and distance obtained from the scanned geometry of the roadway upon which the vehicles are tracked, the vehicle speed, position, and acceleration can be calculated using principles of physics and widely accepted methods of accident reconstruction.

*Figures 18* to *Figures 20* depict the camera matching and video tracking process for one of the security footage cameras. In this example the camera is located on a building with a view of the intersection of Scattergood Street and Eadom Street. The video depicts all three vehicles at the intersection, with Officer Wolk stopping and exiting his vehicle, prior to returning to his vehicle after the motorcyclist had turned east on Eadom Street. The additional vehicle, operated by Mr. Bove, can also be seen in the video at the intersection, stopped adjacent to Officer Wolk.


*Figure 18 – Camera-matching process*

*Figure 19 – Camera-matching process*


*Figure 20 – Camera matching process*

This same process of camera matching this security camera, and tracking the vehicles as observed in the video was repeated for all 7 unique cameras and 9 video files that were analyzed. A total of 8 sequences were analyzed, showing the motion and position of Officer Wolk, Mr. Miller, and Mr. Bove throughout the streets in the neighborhood. The exact path through the streets that was traveled was based on analysis of the video sequences and from review of the documents produced by the Philadelphia Police Departments Internal Affairs Division[4], with one difference. Contrary to the Internal Affairs report, in the sequence that Mr. Miller makes a U-turn in a parking lot at Brill Street and Eadom street, shown in Camera 2, Mr. Miller proceeds down Kennedy Street, rather than Larue Street. The basis for this is the interview with Mr. Mattos, who is recorded as stating that “The motor scooter continued eastbound on Kennedy Street towards James Street.”[5] Further, Officer Wolk testifies that he is “not sure” which side street Mr. Miller took, after his U-turn in the parking lot.[6] Last, the total distance, if assuming the path is on Larue Street, not Kennedy St., yields speeds that achieve or exceed the capabilities of the motorcycle. The full path of travel is depicted in *Figure 21.* The path of the pursuit is denoted in two colors. This denotation is to help clarify the path, since the vehicles pass through the same area twice. The yellow path denotes the time up to when Officer Wolk interacts with Mr. Miller on Eadom St. and Mr. Miller turns around in the parking lot and heads down Kennedy St. Thereafter, the path is denoted in orange.

[4] Video Timeline I.A.D. #19-1066 (Plaintiffs 1.pdf, p.57)
[5] Internal Investigation Memorandum (City Initial Production - Miller - Defense 000001-149.pdf, p. 6)
[6] Deposition of Mr. Wolk, dated May 12, 2023, p. 59

*Figure 21 – Top-down view showing the path of travel of the vehicles based on the 9 sequences that were analyzed.*

A total of 7 cameras captured 9 separate events. In the figure above, the segments are labeled 1 through 9, and correspond to the camera numbers 1 through 9 that at times are duplicate cameras capturing a different moment in time. These 9 segments are summarized below:

1. Mr. Miller and Officer Wolk are first seen in Camera #1, going a left on James St. then right on Simon St.
2. Mr. Miller and Officer Wolk are traveling west on Eadom St. in view of Camera #2, and Mr. Miller turns around in a parking lot, and Mr. Wolk turns around in the street.
3. Mr. Miller, Mr. Wolk, and Mr. Bove travel past Camera #3 located on James St.
4. Mr. Bove turns right on Scattergood St., in view of Camera #4. Mr. Miller and Officer Wolk also turn right. At the corner of Scattergood and Eadom, all three vehicles come to stop before proceeding east on Eadom.
5. Mr. Miller, Mr. Bove, and Officer Wolk travel past Camera #5 on Eadom St.
6. Mr. Miller, Mr. Bove and Officer Wolk travel past Camera #6, which is also Camera #2, on Eadom Street
7. Mr. Miller turns right on Fraley, at Camera #7, followed by Mr. Bove and then Officer Wolk.
8. Mr. Miller, Mr. Bove, and Officer Wolk travel past Camera #8, which is also Camera #1.
9. Mr. Miller impacts the tractor trailer at Fraley St. and Baird St., in view of Camera #9, though the impact itself is not included in the video clip. Mr. Bove is at this intersection and turns right on Tacony St. after the impact. Officer Wolk is seen turning right on James St. after the collision.

**<u>Synchronization of the video files, and bracketing of the total sequence of events:</u>**
The first appearance of Mr. Miller occurred at the corner of James St. and Fraley St. In this first appearance, Mr. Miller is seen turning left on James St., from Fraley St., followed by Officer Wolk. This is identified as location #1 along the yellow path of travel. The last appearance of Mr. Miller in the neighborhood, prior to impact with the tractor trailer, is near the same location, showing Mr. Miller traveling south on Fraley St., identified as #8 in *Figure 21*, and along the orange travel path. Since the same camera captured both the beginning and end of the sequence, the total time it took for this to occur was calculated at 102 seconds. This final sequence is also captured in Camera #9. *Figure 22* depicts the first appearance of Mr. Miller as he is turning on James Street, with a corresponding top down view of this location and time. *Figure 23* depicts the last appearance of Mr. Miller, on Fraley Street with a corresponding top down image and time.


*Figure 22 – First appearance of Mr. Miller turning on James Street at 19:24:03 (left) and corresponding top down view of this location.*


*Figure 23 – Last appearance of Mr. Miller on Fraley Street, prior to the crash, at 19:25:44 (left) and corresponding top down.*

From analysis of the video files, it took Mr. Miller approximately 1 minute 40 seconds to first enter the neighborhood at the intersection of James St. and Fraley St., continue being pursued through the neighborhood, then exit the area, prior to the collision with the tractor trailer. For each area recorded by video, the location, position, speed, and time in the area was tracked and included in the scaled computer model of the scene. Since the total time that all the events took place within the neighborhood is known, at 102 seconds, the sequence of events within that time frame can be synchronized, based on the total path that was taken, and by assuming an average speed in the areas where the vehicles were not captured on video. Average speeds were determined in the areas not captured on video by analyzing the last known speed before they went out of view and analyzing the known speed at the next sequence they come into view. Small differences in speeds, in these areas not captured on video, would not affect the outcome of this analysis, or change the visualization in any significant way. *Figure 24* depicts three images of the tracking of Officer Wolk's patrol vehicle and Mr. Miller's motorcycle as they enter and exit the view of Camera 01. These images show the overlay of the computer models vehicle and scan data to the background video file. *Figure 25* depicts the same moments in time, showing the positions of the tracked vehicles from a top down view. The time code, counting down to the time of impact, has been added to the top down images.


*Figure 24 – Camera matched view of Camera 01, showing the tracking of Officer Wolk's Patrol vehicle and Mr. Miller's motorcycle.*


*Figure 25 – Top down view of the vehicle tracking for Camera 01.*

**<u>Modeling the motion Using PC Crash Software:</u>**
To model the motion, relative positions, timing and dynamics of this sequence, and to be able to measure acceleration, deceleration and steering and swerving inputs, JS Held utilized an accident analysis software package called PC-Crash. This software package utilizes physics-based equations (Newton's laws of motion, conservation of momentum, conservation of energy, etc.) to calculate the motion of vehicles caused by driver steering, braking, and acceleration inputs or by collision forces. The software allows the analyst to specify the vehicle and scene geometries and the roadway surface conditions, and then to simulate the motion of the vehicles.

PC-Crash is a software package that is commonly and widely utilized by accident reconstructionists, law enforcement officers, insurance companies, the automotive industry, and universities to analyze vehicular collisions. According to DSD GmbH, the developer of PC-Crash, "More than 6000 installations of the software show that it has become one of the leading tools for traffic accident reconstruction."[7] PC-Crash software has been validated for accident reconstruction and subjected to peer-review and publication. The validation process of PC-Crash software is documented and described in the references below. These publications also include data related to the rate of error of analysis with PC-Crash.

- Andrews, Stanley B., et al., "A Comparison of Computer Modeling to Actual Data and Video of a Staged Rollover Collision," Enhanced Safety of Vehicles (ESV) Conference, 2009, Paper Number 09-0346.

[7] http://www.dsd.at/index.php?option=com_content&view=article&id=76:pc-crash&catid=37&Itemid=207&lang=en

- Bailey, Mark N., "Data from Five Staged Car to Car Collisions and Comparison with Simulations," Society of Automotive Engineers Technical Paper Number 2000-01-0849.

- Cliff, William E., "Validation of PC-Crash – A Momentum-Based Accident Reconstruction Program," Society of Automotive Engineers Technical Paper Number 960885.

- Cliff, William E., "The Measured Rolling Resistance of Vehicles for Accident Reconstruction," Society of Automotive Engineers Technical Paper Number 980368.

- Cliff, William E., "Yaw Testing of an Instrumented Vehicle with and without Braking," Society of Automotive Engineers Technical Paper Number 2004-01-1187.

- Cliff, William E., Moser, Andreas, "Reconstruction of Twenty Staged Collisions with PC-Crash's Optimizer," Society of Automotive Engineers Technical Paper Number 2001-01-0507.

- Heinrichs, B., Mac Giolla Ri, B., and Hunter, R., "Sensitivity of Collision Simulation Results to Initial Assumptions," SAE Int. J. Passeng. Cars – Mech. Syst. 5(2):2012.

- Heinrichs, B., Goulet, J., Fix, R., and King, M., "Measuring and Modeling Suspensions of Passenger Vehicles," SAE Technical Paper 2013-01-0774.

- Kiefer, Aaron, Bilek, David, Moser, Andreas, Webb, Andrew, "A Comparison Study between PC-Crash Simulation and Instrumented Handling Maneuvers," SAE Technical Paper Number 2011-01-1121.

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PC-Crash has also been widely utilized and accepted in previous legal matters involving vehicular collisions. The North American distributors of PC-Crash (MEA Forensic) have compiled a list of more than 200 instances of PC-Crash being admitted for use in expert testimony in court proceedings. The list maintained by MEA is populated based on voluntary user reports, and so, the actual number is higher. In a recent Colorado ruling related to the admissibility of PC-Crash (Graham v Sharples in El Paso County), the court found that PC-Crash "can and has been tested…has been subjected to peer review and publication…PC-Crash accident reconstruction software is 'generally accepted'…PC-Crash software is reasonably reliable."

The use of PC Crash in this case involved using physics based vehicle parameters within PC Crash to match the location and time of these vehicles as determined through camera matching photogrammetry and video tracking. The positions and times as determined through camera matching and video tracking were imported into PC Crash as a background, where physics based vehicles were modeled to match these positions and times governed the vehicle specifications and limitations, and methods of accident reconstruction. By using PC Crash to model the motion of the vehicles, the speed, acceleration, deceleration and steering and swerving inputs could be quantified and analyzed. *Figure 26* depicts images from PC Crash showing the motion of Officer Wolk's vehicle, relative to Mr. Miller's motorcycle, as recorded by Camera 02. *Figure 27* Depicts images from PC Crash showing the motion of Officer Wolk's vehicle, Mr. Miller's vehicle, and Mr. Bove's vehicles as recorded by Camera 04. Appendix C and Appendix D have been included that detail the analysis of Officer Wolk's vehicle motion. This process was performed for the entire sequence of the pursuit.

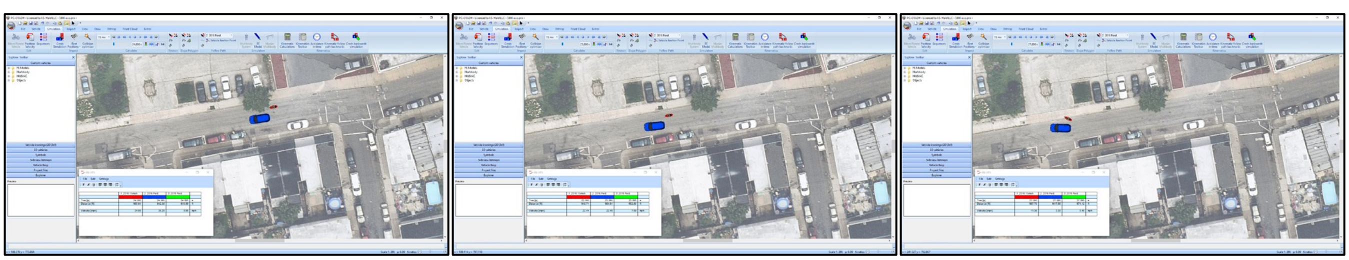

*Figure 26 – PC Crash screen shots showing the motion of Officer Wolk and Mr. Miller as recorded in Camera 02 (Appendix C).*

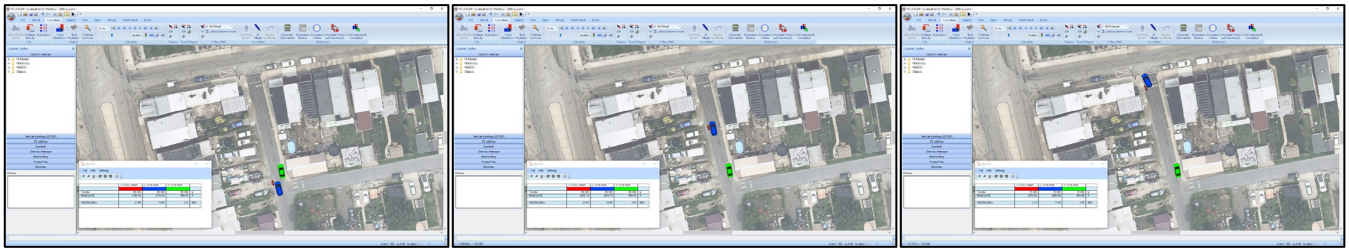

*Figure 27 – PC Crash screen shots showing the motion of Officer Wolk, Mr. Miller, and Mr. Bove as recorded in Camera 04 (Appendix D).*

The tracking process, and subsequent modeling of the vehicles' motion in PC Crash allowed an animation to be created, that shows the full sequence of the pursuit in real time, from the initial entrance into Camera 01 by Mr. Miller and Officer Wolk, till Mr. Miller's impact with the tractor trailer at the end of the pursuit. *Figure 28* depicts still images from the animation which plays at real time, and displays the location and speed of each vehicle, based on the analysis of the video recording of the cameras, principles of physics, time and space relationships, and accident reconstruction. This animation is included as *Appendix E.*

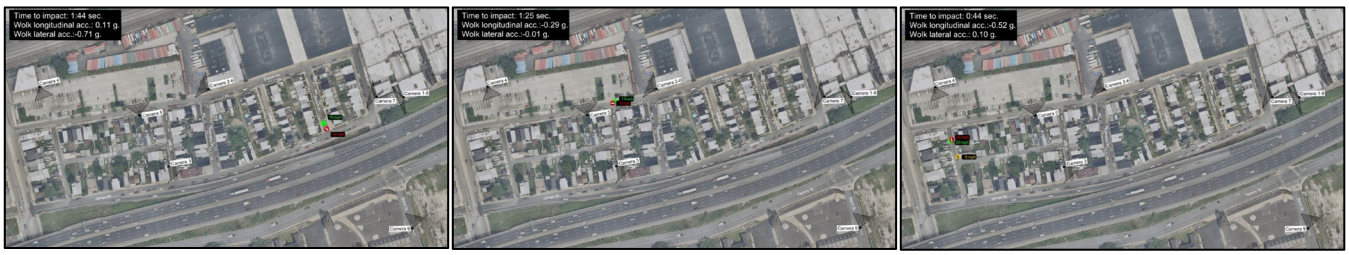


*Figure 28 – Full sequence of the pursuit from a top down view (Appendix E).*

**<u>Analysis of the motion of Officer Wolk's patrol vehicle:</u>**
Based on the full sequence of the pursuit through the neighborhood, from the initial entrance and leading up to impact, an analysis of the speeds, accelerations, decelerations, and swerving that Officer Wolk achieved was performed. One analysis included determining the maximum speed that Mr. Wolk achieved on each street in the 25 mph speed limit neighborhood. *Figure 29* depicts the analysis, showing the speeds along the respective streets that this speed was achieved. From the analysis, it was determined that Officer Wolk exceeded the speed limit along every straight segment, and reached a speed approximately twice the speed limit when traveling on Eadom St.


*Figure 29 – Analysis showing Officer Wolk's top speeds along straight-aways*

In addition to the analysis determining the maximum speeds achieved by Officer Wolk during his pursuit of Mr. Miller, JS Held also analyzed two specific sequences in which Officer Wolk's vehicle blocked the travel path of Mr. Miller. These events are referred to in this report as Event #1 and Event #2. These two events occurred at Camera #2 and Camera #4 respectively. In the first event, Officer Wolk is traveling adjacent to Mr. Miller on Eadom St. and sharply turns and stops in front of Mr. Miller's travel path. In the second event, Officer Wolk is traveling on Scattergood Street and comes from behind Mr. Miller, passes Mr. Miller on the right, then sharply turns and stops in Mr. Miller's path of travel. *Figure 30* and *Figure 31* are zoomed images from Camera 2 and Camera 4 that depict these events.

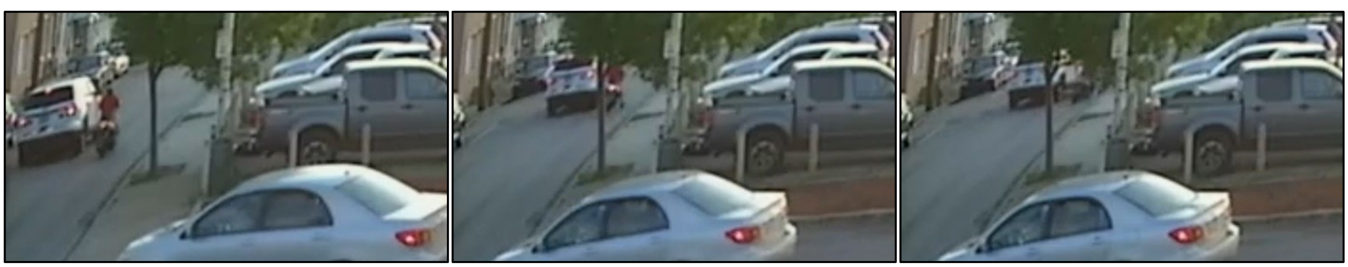

*Figure 30 – Still Images from Camera-02 – showing Officer Wolk turning in front of Mr. Miller's path of travel.*

*Figure 31 – Still Images from Camera-04 – showing Officer Wolk turning in front of Mr. Miller's path of travel.*

**Analysis of Event #1 – Officer Wolk blocks the travel path of Mr. Miller in Camera #2:**
Based on the video tracked positions of Mr. Miller and Officer Wolk in Camera #2, JS Held analyzed the speed and acceleration/deceleration of Officer Wolk in this sequence. When the vehicles enter the field of view of Camera #2, Officer Wolk is traveling approximately 35 mph and Mr. Miller is traveling approximately 35 mph. From analysis of the video, Officer Wolk first initiates an abrupt braking and swerving maneuver when he is adjacent to Mr. Miller. Thereafter, Officer Wolk applies brakes, swerves to the right, and blocks the path of travel of Mr. Miller. This maneuver occurs PRIOR to Mr. Miller changing the direction of his motorcycle. Only after Officer Wolk swerves and brakes to the right does Mr. Miller perform an avoidance maneuver. *Figure 32 depicts* three images from the tracked sequence, that show Officer Wolk adjacent to Mr. Miller, then applying brakes and blocking the travel path of Mr. Miller. A top down sequence that plays in real time is included as *Appendix F*.


*Figure 32 – Top view close up of Event #1, Camera 02 – Officer Wolk blocks the travel path of Mr. Miller (Appendix F).*

From analysis of the video, it was determined that the brake application by Officer Wolk was approximately 0.6 g, and that his lateral maneuver was directly in the path of travel on which Mr. Miller was headed. This level of braking is characterized as hard braking, and **since Officer Wolk's decision to brake hard and swerve into the path of travel of Mr. Miller was not in response to a hazard and occurred prior to Mr. Miller steering his scooter to the right, both the braking and steering maneuver were intentional, and not reactive**. By braking and steering in a hard manner, Officer Wolk intentionally placed his vehicle in the path of Mr. Miller such that his vehicle became a sudden and immediate hazard that Mr. Miller was required to avoid. However, Officer Wolk could not have known Mr. Miller's skills and abilities to avoid this collision, and without an emergency response by Mr. Miller a collision likely would have occurred. Based on research, it is unlikely that other drivers faced with a similar immediate hazard as Mr. Miller was faced with, would have been able to avoid this collision[8,9,10,11,12]. In short, **Officer Wolk intentionally blocked Mr. Miller's path of travel, creating an immediate hazard that Mr. Miller only avoided by performing above average levels of braking and swerving. Since only high performance braking and swerving maneuvers by a rider would avoid this collision, the actions by Officer Wolk would have resulted in a collision and, given Mr. Miller's vulnerability on a scooter, would have likely resulted in injuries.** Even for this specific event, Officer Wolk was aware of the inherent vulnerabilities of scooter operators:[13]

> 20 A. He turned into the parking lot
> 21 which I turned also in. I would not put my
> 22 vehicle in front of a moving scooter like that.
> 23 Q. And why not?
> 24 A. It would cause serious bodily
> 1 injury.

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[8] Rose, N., Neale, W., "Motorcycle Accident Reconstruction", ISBN 978-0-7680-9507, Society of Automotive Engineers, Warrendale PA, 2019.
[9] Muttart, J., "Drivers' Response in Emergency Situations," Crash Safety Solutions LLC, 2017
[10] Muttart, J., "Development and Evaluation of Driver Response Time Predictors Based upon Meta Analysis," SAE Technical Paper 2003-01-0885, 2003, doi:10.4271/2003-01-0885.
[11] Muttart, J., "Quantifying Driver Response Times Based Upon Research and Real Life Data," Proceedings of the Third International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, 2005.
[12] Muttart, J., "Estimating Driver Response Times," Chapter 14 in Handbook of Human Factors in Litigation, edited by Y. Ian Noy and Waldemar Karwowski, CRC Press, 2004.
[13] Deposition of Officer Joseph Wolk, May 12, 2023, p. 48, lines 20-24 to p. 49 line 1.

From analysis of the video, it was determined that Officer Wolk did not "also" turn into the parking lot. Rather, Officer Wolk performed a three-point turn around in the roadway, before eventually removing his vehicle as a hazard in the roadway and continuing the pursuit of Mr. Miller.

**<u>Analysis of Event #2 – Officer Wolk passes then blocks the travel path of Mr. Miller in Camera #4:</u>**
Based on the video tracked positions of Mr. Miller and Officer Wolk in Camera #4, JS Held analyzed the speed and acceleration/deceleration of Officer Wolk in this sequence. At the start of this sequence, Officer Wolk is behind Mr. Miller. At the end of the sequence, Officer Wolk is stopped, and in front of Mr. Miller. These facts require Officer Wolk to have passed Mr. Miller, and, as in the previous event, swerve and brake into the path of travel of Mr. Miller. *Figure 33* is a top down sequence showing the positions of the vehicles when they enter the camera's field of view, leading up to the time Officer Wolk accelerates past Mr. Miller and then blocks his travel path of Mr. Miller. A top down sequence that plays in real time is included as *Appendix E*.

*Figure 33 – Top view sequence of Event #2, Camera 04 – Officer Wolk blocks the travel path of Mr. Miller. (Appendix G)*

From analysis of the video, it was determined that Officer Wolk initiated a passing maneuver, accelerating at approximately 0.3 g, which is characterized as rapid acceleration for that vehicle in this situation.[14] After passing Mr. Miller, with only a few feet of separation, Officer Wolk applied brakes at a rate of approximately 0.5 g, and swerves laterally at approximately 0.2g. This level of braking and swerving approaches the maximum friction available on the roadway. **In summary, Officer Wolk rapidly accelerated past Mr. Miller and then intentionally applied hard braking and swerving to, again, position his vehicle into the direct travel path of Mr. Miller. Had Officer Wolk applied slightly harder braking and swerving he would have lost control of his vehicle due to loss of traction on the roadway. Since Officer Wolk could not know the reaction of Mr. Miller prior to making this decision, the expected result would be that Mr. Miller would collide with the side of Officer Wolk's vehicle, likely resulting in injuries that Officer Wolk already anticipated.[15]**

**<u>Summary of Opinions and Conclusions</u>:**
**Camera 1:**
- Mr. Miller entered the neighborhood approximately 110 seconds before impact with the tractor trailer.
- Mr. Miller entered the neighborhood traveling approximately 20 mph.
- Officer Wolk entered the neighborhood traveling approximately 20 mph.
- Officer Wolk approached within 17 feet of Mr. Miller's motorcycle.

**Camera 2:**
- Mr. Miller entered the field of view of Camera 2, traveling approximately 35 mph.
- Officer Wolk entered the field of view of Camera 2, traveling approximately 35 mph.
- Officer Wolk intentionally braked and steered into the travel path of Mr. Miller, with the likely outcome that Mr. Miller would impact Officer' Wolk's vehicle, resulting in "serious bodily injury".
- Officer Wolk stopped in the roadway, made a three-point U-turn, then proceeded behind Mr. Miller

**Camera 3:**
- Mr. Miller is seen in Camera 3 traveling approximately 33 mph.
- Officer Wolk is seen in Camera 3 traveling approximately 40 mph.
- Mr. Bove is first seen in Camera 3. This is 75 seconds from impact with the tractor trailer.
- Mr. Bove is traveling approximately 33 mph.

[14] Fricke, L., "Traffic Accident Reconstruction" Vol. 2, Northwestern University Center for Public Safety, Ex. 39, p. 62-38.
[15] Deposition of Officer Joseph Wolk, May 12, 2023, p. 48, lines 20-24 to p. 49 line 1.

**Camera 4:**
- Officer Wolk accelerates at 0.3 g, and passes Mr. Miller on Scattergood St.
- After passing, Officer Wolk intentionally braked and steered into the travel path of Mr. Miller, with the likely outcome that Mr. Miller would impact Officer Wolk's vehicle, resulting in "serious bodily injury".
- Mr. Bove pursues Mr. Miller, after Mr. Miller proceeds down Eadom St.

**Camera 6**:
- Mr. Miller is seen in Camera 6 traveling approximately 40 mph.
- Officer Wolk is seen in Camera 6 traveling approximately 47 mph.
- Mr. Bove is seen in Camera 6 traveling approximately 50 mph.

**Camera 7:**
- Mr. Miller enters the field of view of Camera 7 14 seconds before impact with the tractor trailer.
- Officer Wolk enters the field of view of Camera 7 10 seconds before impact with the tractor trailer.
- Mr. Bove enters the field of view of Camera 7 4 seconds before impact with the tractor trailer.

**Camera 8:**
- Mr. Miller is seen in Camera 8 traveling approximately 34 mph.
- Officer Wolk is seen in Camera 8 traveling approximately 20 mph.
- Mr. Bove is seen in Camera 8 traveling approximately 37 mph.

**Camera 9:**
- Mr. Miller impacts the tractor trailer approximately 110 seconds after entering the neighborhood.
- Officer Wolk is seen in Camera 9, turning right onto James St., away from the area of impact, 3 seconds after the crash.
- Mr. Bove is seen in Camera 9, turning right onto Tacony St., away from the area of impact, 3 seconds after the crash.

**Speed Analysis and Driver Behavior:**
- During the pursuit, Officer Wolk exceeded the speed limit on every straightaway.
- During the pursuit, Officer Wolk traveled approximately twice the speed limit on Eadom St.
- During the pursuit, in Camera 2 and Camera 4, Officer Wolk passed Mr. Miller by crossing into oncoming lanes of traffic.
- On at least two occasions, Officer Wolk forced Mr. Miller to perform an emergency maneuver to avoid an impact with Officer Wolk's vehicle. Since Officer Wolk knew a motorcyclist is vulnerable and susceptible to injury if Mr. Miller impacted his vehicle, Officer Wolk intended to cause a crash with, and injuries to, Mr. Miller.

## Closing

The opinions and conclusions expressed in this report were reached to a reasonable degree of scientific certainty based on our investigation and analysis to date. We intend to utilize the videos, documents, devices, photographs and other material collected and utilized during JS Held's testing to assist in communicating and explaining our findings. Additional graphics, animations, and other visual material may also be created to assist JS Held in demonstrating and communicating the opinions and procedures expressed above. Further information, data, investigation, or analysis may lead us to review or supplement these opinions and conclusions. A copy of our testimony list, and JS Held's current fee sheet is included as *Appendix H* and *Appendix I*.

Sincerely,

William T.C. Neale, M. Arch.
Director of Visualization

ACTAR ACCREDITED
ACTAR
2571
WILLIAM T. C. NEALE

**List of Appendices:**

Appendix A – Resume of William Neale (PDF)
Appendix B – List of Provided Documents (PDF)
Appendix C – PC Crash analysis of the vehicle motion in Camera 02 (PDF)
Appendix D – PC Crash analysis of the vehicle motion in Camera 04 (PDF)
Appendix E – Top down animation of the tracked vehicle sequence (MP4)
Appendix F – Top down close up sequence of Camera #2 (MP4)
Appendix G – Top down close up sequence of Camera #4 (MP4)
Appendix H – William Neale 4 year Testimony List (PDF)
Appendix I – JS Held's 2023 Fee Sheet (PDF)